MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2215)

EEN1046 –ELECTRONICS III

(TE / RE)

20 FEBRUARY 2023
2.30 p.m. - 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages excluding the cover page and appendix with 4 Questions only.

2. Answer ALL questions . All questions carry equal marks and the distribution of the marks for each question is given .

3. Please write all your answers in the Answer Booklet provided .

Q1.

(a) State four differences between an ideal op amp and practical op amp.

[4 marks]

(b) Draw the diagram of inverting summing amplifier. Show the analysis of the KCL and express V_{out} in term of V_1, V_2 and V_3 with respective R_1, R_2 and R_3.

[7 marks]

(c) Design a Practical Differentiator Op-Amp with cutoff frequency of f_c = 20kHz. The close loop gain A_v=-20 at very high frequency. Draw the Practical Differentiator diagram and label with details.

[6 marks]

(d) A bandpass filter has Q=20 and Bandwidth = 20kHz. Calculate f_H, f_L and f_o.

[5 marks]

(e) A 3rd order low-pass filter with center frequency fc = 10kHz has -60dB/decade attenuation. Determine the normalized gain A_v in dB at f = 50kHz. [3 marks]

Continued ...

Q2. (a)A filter has a voltage transfer function of

$$H(s) = \frac{\frac{40x10^6}{s^2}}{\frac{4x10^6}{s^2} + \frac{100}{s} + 1}$$

Determine the type and order of this filter. Hence, calculate the value of K, Q and ω_o. [6 marks]

(b) Design a non-inverting 1st order high pass filter with Av = 5 and fc = 10kHz. The choice of resister used should be ≥10kΩ. Draw the high pass filter circuit and label the components value accordingly. [8 marks]

(c) Given the op amp in figure Q2(a) having CMRR = 90dB. If the A_{OL} = 200,000. Determine the A_{CM} and V_o of the circuit. [4 marks]

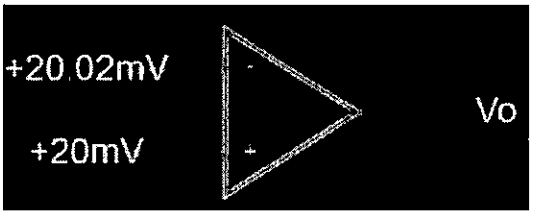

Figure Q2(a)

(d)

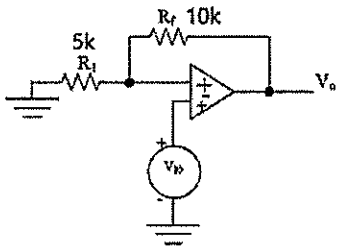

Figure Q2(b)

Consider the above op-amp circuit in figure Q2(b), calculate the output offset voltage due to input bias current (V_{os1}), the output offset voltage due to input offset current (V_{os2}), the output offset voltage due to input offset voltage (V_{os3}) and the total output offset voltage (V_{os}). Assume the op-amp LM358 is used (input offset current=50nA, input bias current=125nA, input offset voltage=5mV). [7 marks]

Continued ...

Q3

(a) For the inverting amplifier shown in Figure Q3(a) below, calculate the input impedance Z_{in} and output impedance Z_{out}. [5 marks]

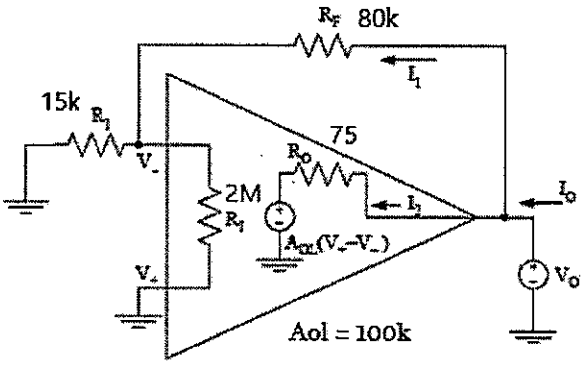

Figure Q3(a)

(b)

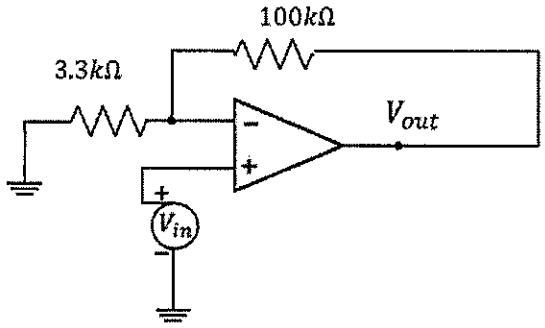

Figure Q3(b)

Calculate the closed loop bandwidth for the non-inverting amplifier shown in Figure Q3(b). The unity gain bandwidth offered by above op amp is 10MHz. [4 marks]

(c) Determine the line regulation S_L (%) when the input voltage drop by 10V and the output voltage decrease by 0.5V. [3 marks]

Continued ...

Q3

(d) Figure Q3(c) is the series feedback regulator circuit. Briefly discuss how this circuit is capable to regulate V_o when V_o increase or decrease. [5 marks]

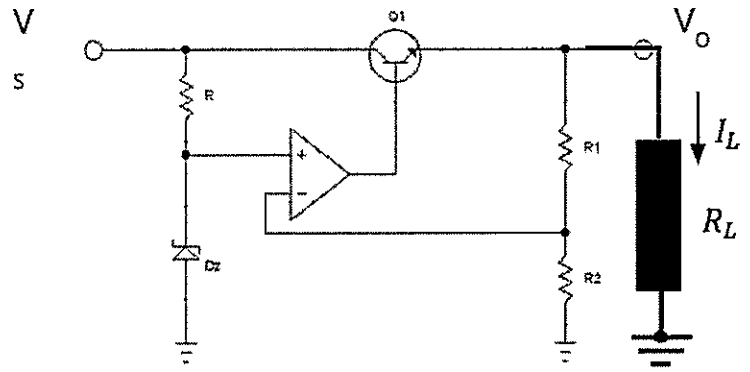

Figure Q3(c)

(e) From the figure Q3(d) below, calculate the value of V_o, R_s and I_L and I_C for the shunt regulator circuit where Is = 100mA and R_L = 125Ω. [8 marks]

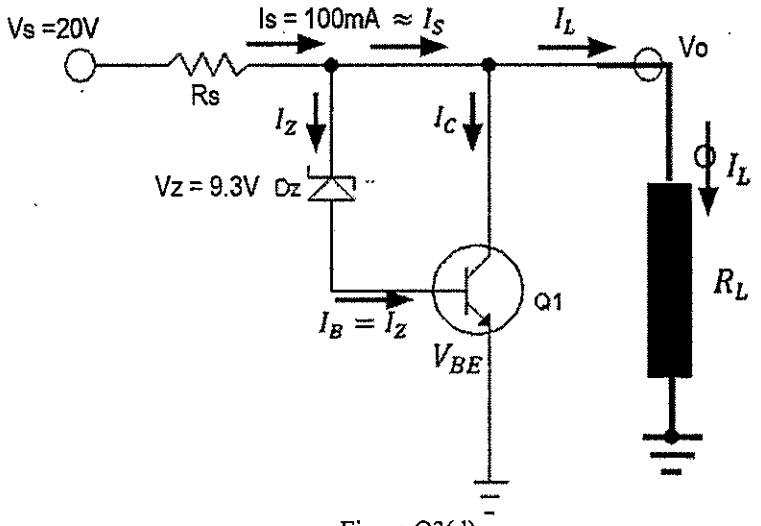

Figure Q3(d)

Continued ...

Q4 (a) What is the gain needed by a sine wave oscillator if the feedback gain β= 0.1. [2 marks]

(b) Figure Q4(a) shows a sinusoidal oscillator.

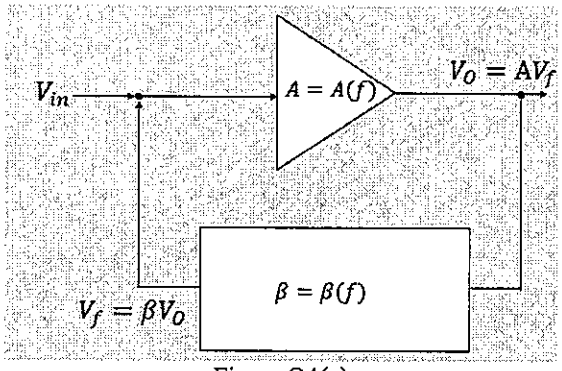

Figure Q4(a)

Given the voltage gain A and feedback gain β as below:

$$A_v = \frac{K}{\frac{jw}{2000} + 1} \qquad \beta = \frac{1}{1 - \frac{j2000}{w}}$$

Using Barkhausen Criterion, calculate the value K and the frequency. [7 marks]

(c) Design a Colpitts oscillator with an oscillation frequency of 10kHz.
Draw the Colpitts oscillator circuits with the components labelled. [8 marks]

Hint: both the capacitors value is equal.

(d) Figure Q4(b) below is an op amp comparator waveform.

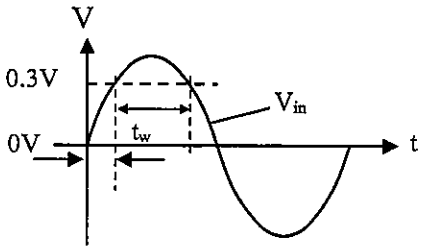

Figure Q4(b)

Given V_{in} = 0.5 sin (2000πt) V and V_{ref} = 0.3V. Find the duty cycle t_w of this waveform. Hence sketch the output of this comparator. [8 marks]

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APPENDIX 1

Filter type	k_o, k_1, k_2	Voltage transfer function
Low-pass	1, 0, 0	$H_{LP}(s)=\dfrac{K\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
High-pass	0, 0, 1	$H_{HP}(s)=\dfrac{Ks^2}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-pass	0, 1, 0	$H_{BP}(s)=\dfrac{K(\omega_o/Q)s}{s^2+(\omega_o/Q)s+\omega_o^2}$
Band-reject	1, 0, 1	$H_{BR}(s)=\dfrac{K(s^2+\omega_o^2)}{s^2+(\omega_o/Q)s+\omega_o^2}$
All-pass	1, -1, 1	$H_{AP}(s)=K\dfrac{s^2-(\omega_o/Q)s+\omega_o^2}{s^2+(\omega_o/Q)s+\omega_o^2}$

Biquadratic voltage transfer function (2nd-order system)